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Then  $x^x + (2.83)^{2.83} = 285$ .  $x^x = 266.00867$ .  $x \log x = \log 266.00867$ .  $x = 4.01605$ .

Substituting in equation (2) as before  $(2.83)^{4.01605} - (4.01605)^{2.83} = 14.083487$ .  $14.083487 - 14 = 0.083487$  error. Then

$$\frac{0.471434 \times 2.83 - 0.083487 \times 2.85}{0.471438 - 0.083487} = 2.825696.$$

Bonnycastle's answer for  $y$  is 2.825716.

Again  $x^x + (2.825696)^{2.825696} = 285$ .  $x^x = 266.17636274$ .  $x \log x = \log 266.17636274$ .  $x = 4.016348$ .

Bonnycastle's answer for  $x$  is 4.016698.

These trifling discrepancies may easily be occasioned by variation in the logarithmic tables used. I have made use of Chambers's seven place tables.

I have not succeeded in effecting a neat and satisfactory solution; by trial, however, I find, approximately,  $x = 3.89$ ,  $y = 3.54$ . G. B. M. ZERR.

I do not believe a strictly algebraic solution of this problem can be given, because it is not an algebraic, but a transcendental function. Algebraically there are really four unknowns,  $x$ ,  $\log x$ ,  $y$ , and  $\log y$ . Of course,  $\log x$  and  $\log y$  are known if  $x$  and  $y$  are known, but they are here algebraically separate unknowns because of the manner in which they enter the equations. W. H. DRANE.

## GEOMETRY.

114. Proposed by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.

If a variable ellipse hyperosculate a fixed ellipse at the extremity of the minor axis, the locus of the foci is a circle whose diameter is equal to the radius of curvature.

Solution by the PROPOSER.

Let  $x^2/a^2 + y^2/b^2 = 1$ .....(1) be the given ellipse; then the tangent at the vertex of the minor axis is  $y/b - 1 = 0$ .....(2), and the variable conic is

$$x^2/a^2 + y^2/b^2 - 1 - \lambda[(y/b) - 1]^2 = 0$$
.....(3), or

$$x^2/a^2 + (1 - \lambda)(y^2/b^2) + (2\lambda/b)y - (\lambda + 1) = 0$$
.....(4).

Now, the foci of the general conic

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$$
.....(5),

are given by

$$C(x^2 - y^2) + 2Fy - 2Gx + A - B = 0$$
.....(6),

$$Cxy - Fx - Gy + H = 0 \dots\dots(7),$$

in which  $A=bc-f^2$ ,  $B=ca-g^2$ ,  $C=ab-h^2$ ,  $F=gh-af$ ,  $G=hf-bg$ ,  $H=fg-ch$ .

For the conic (4),  $A=-1/b^2$ ,  $B=-[(1+\lambda)/a^2]$ ,  $C=[(1-\lambda)/(a^2b^2)]$ ,  $F=-\lambda/a^2b^2$ ,  $G=H=0$ , and these in (6) and (7) give

$$(1-\lambda)(x^2-y^2)-2b\lambda y+b^2(1-\lambda)-a^2=0\dots\dots(8),$$

$$(1-\lambda)y+b\lambda=0\dots\dots(9).$$

Eliminating  $\lambda$  from (8) and (9), the required locus is

$$x^2+y^2+\frac{a^2-2b^2}{b}y=a^2-b^2\dots\dots(10).$$

This is a circle, radius  $a^2/2b$ , or one-half the radius of curvature of (1) at the extremity of the minor axis.

115. Proposed by MARY M. BLAINE, B. Sc., Graduate Student, Drury College, Springfield, Mo.

The locus of a point such that the sum of the squares of its normals form a given ellipsoid is constant, is a co-axial ellipsoid. [From *C. Smith's Solid Analytical Geometry*, page 95.]

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Science, Chester High School, Chester, Pa.

Let  $(l, m, n)$  be the point whose locus is required. Then from the conditions of the problem we have

$$\begin{aligned} &(l-x_1)^2+(l-x_2)^2+(l-x_3)^2+(l-x_4)^2+(l-x_5)^2+(l-x_6)^2 \\ &+(m-y_1)^2+(m-y_2)^2+(m-y_3)^2+(m-y_4)^2+(m-y_5)^2+(m-y_6)^2 \\ &+(n-z_1)^2+(n-z_2)^2+(n-z_3)^2+(n-z_4)^2+(n-z_5)^2+(n-z_6)^2=C^2. \end{aligned}$$

This equation can be written more briefly thus :

$$\begin{aligned} &\Sigma(l-x_i)^2+\Sigma(m-y_i)^2+\Sigma(n-z_i)^2=C. \\ \therefore C(l^2+m^2+n^2)-2[l\Sigma(x_i)+m\Sigma(y_i)+n\Sigma(z_i)] \\ &+\Sigma(x_i^2)+\Sigma(y_i^2)+\Sigma(z_i^2)=C^2\dots\dots(1). \end{aligned}$$

The equation of the normal is

$$(a^2/x)(l-x)=(b^2/y)(m-y)=(c^2/z)(n-z)\dots\dots(2).$$

$$\text{Also, } x^2/a^2+y^2/b^2+z^2/c^2=1\dots\dots(3).$$